GENtrace™ cyclotron

Data sheet

Overview

The GE Healthcare GENtrace‡ cyclotron is a compact, automated, single-particle cyclotron designed for fast, easy and efficient production of PET isotopes. It offers the ability to meet your clinical needs and flexibility for your research programs.

The GENtrace cyclotron is a negative ion cyclotron using GE's industry leading vertical mid-plane design, giving you the benefits of a compact footprint and easy maintenance.

The PET isotopes produced by the GENtrace are fluorine-18 and carbon-11. For efficient conversion into finished PET precursors and tracers, we recommend transferring these isotopes to either a FASTlab™ 2 or TRACERlab™ FX2 chemistry processing system.

Primary benefits

Easy to use

The entire sequence of producing the PET isotopes is fully automated. Similar to the workflow required for the operation of a generator (for example Tc-99m), the technician will only need to select the desired isotope and the amount of activity required. The control system automatically prepares the cyclotron and the targets, tunes the beam and manages the target irradiation.

Sufficient production capacity

The GENtrace cyclotron is optimized for in-house hospital operation. The production capacity of the cyclotron is sufficient for at least twelve doses of FDG per production. A second production can be initiated immediately after the first production.

Increase reliability

Several technical innovations and improvements have been introduced to increase the reliability of this GE cyclotron. A hydrogen gas generator, a piezoelectric beam extraction driver, and a turbo molecular vacuum pump are among the new features in the GENtrace cyclotron.

Lower dose to personnel

The vertical mid-plane design of the cyclotron and quick release components assist in significantly reducing the radiation dose to maintenance personnel. The reduction in potential radiation exposure is further facilitated by the separation of the targets from the cyclotron magnet by a beam pipe. The beam pipe, an industry first innovation, enables separate access to one area of the cyclotron while protecting the service technician from potential exposure from the other area.

Maximized uptime

The GENtrace cyclotron has been designed to provide reliable and robust production for at least 6 months of usage before maintenance is required†. The target, ion source and extraction systems have redundancies and technical features built in to minimize downtime for maintenance interventions.

Remote connectivity for support and data analysis is accessible through the GE Online Center.

System configuration

Magnet

The design and composition of the GENtrace cyclotron magnet system offers simple and robust operation. The iron in the magnet yoke also acts as a part of the radiation shielding. The magnet is water-cooled by a closed-loop cooling water system. Hardware interlocks continuously monitor the cooling water flow and temperature. This improves the stability of the ^{18}F-fluoride production and increases the reliability and uptime of the overall system.

Radiofrequency (RF) system

The RF system consists of two interconnected Dees, which form a resonator, and an RF Power Generator.

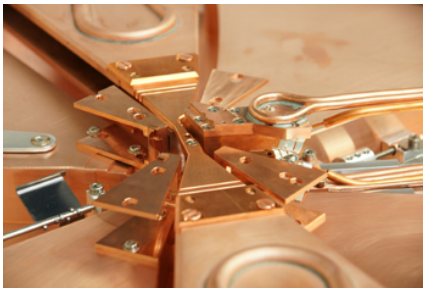
Within the vacuum chamber, the RF system accelerates particles to the desired energy. This operation is automatically regulated by the accelerator control system.

Ion source and hydrogen gas generator

The GENtrace cyclotron ion source, which is mounted internally in an adjustable position, is a Penning Ionization Gauge (PIG) discharge type design where the cathodes are heated by the discharge.

Designed for a fast exchange and efficient maintenance, the ion source includes a GE patented mechanism to ensure precise alignment for optimal beam regulation and a maximal life for the ion source.

A hydrogen gas generator supplies the ion source with very clean gas. This significantly increases the lifetime of the ion source. The gas generator also eliminates the potential hazardous risks of working with hydrogen gas and the need for an expensive gas line installation.



Ion source

Beam extraction

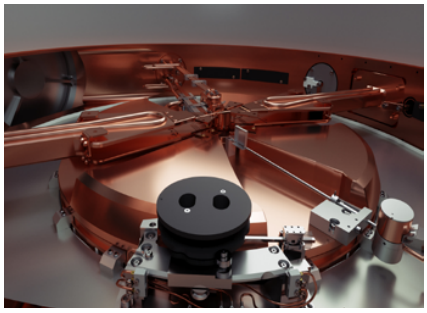
The GENtrace cyclotron has a unique beam extraction system with a piezoelectrically driven mechanism. This enables accurate beam regulation which is critical for positioning the beam precisely into the target.

The entire extraction foil carousel is made of graphite, a material selected for its stability in high vacuum and temperature conditions.

Eight carbon foils within the carousel ensure system redundancy and longevity.

Beam diagnostics

The beam current is continuously monitored by the beam diagnostic system to fully automate the start-up, tuning and operation of the beam.

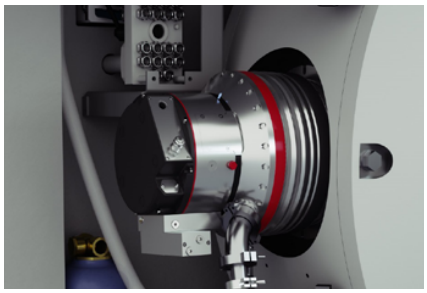


Extraction foil carousel

Vacuum system

The GENtrace cyclotron vacuum system consists of a high vacuum turbo molecular pump mounted directly on the magnet yoke and a mechanical roughing pump. This differentiates the GENtrace cyclotron from all other cyclotrons on the market today.

A clean vacuum provided by the turbo molecular pump is key to the robust and stable beam in the GENtrace cyclotron. A dedicated vacuum system controller performs pressure monitoring, vacuum pump sequencing and system operation. The magnet yoke replaces the standard vacuum chamber and completely encapsulates the acceleration chamber which contributes to the increased reliability of the GENtrace cyclotron.



Turbo molecular pump

Target mounting and support

There are three available target positions at the end of the beam pipe. The beam pipe also separates the targets from the accelerator chamber which contributes to the reduction in dose to the service personnel. The mounting flange and targets permit rapid and convenient installation and removal of targets to minimize dose exposure.

The target systems do not require helium cooling due to a grid-supported foil design. The elimination of the helium cooling system offers significantly improved reliability as well as maximized beam energy on target.

User control and interface

The GENtrace cyclotron control system is equipped with an accelerator control unit and a PC client station. Additional client stations can be purchased to allow control of the cyclotron from more than one location.

To produce the tracer, the user simply selects the type of isotope and the amount of activity and then starts the production sequence. The control system carries out all the automated closed-loop and logical control tasks to provide unattended beam control and regulation. The operator can perform tasks away from the control system and is not required to physically supervise the production. During the production, the client station displays the system status, the amount of activity produced and when the desired activity amount will be ready for delivery.

The control system functions include:

- Automatic system start-up, including sub-system verification and monitoring
- Automatic beam tuning to optimize system operation and efficiency
- Continuous monitoring of system operating parameters, with appropriate protection interlocks and warnings.
- Batch report with a printout possibility
- Data logging of operational parameters
- Remote connectivity for support and data analysis by GE Online Center.

Radiation shield

The GENtrace cyclotron comes with an efficient self-shield with an average dose rate of less than 3 µSv/h on the surface. This low dose rate will in almost all cases permit siting in rooms with existing walls and infrastructure in place without any reinforcement[#]. The modular radiation shield design permits simple transportation into an existing building. The radiation shield has separate doors for the accelerator and targets, reducing radiation exposure during service and maintenance interventions.

The vacuum pump is also accessible through a separate door. The GENtrace cyclotron's sub-systems are uniquely housed at the rear of the shielding, enabling fast and easy installation and maintenance.

GENtrace cyclotron radiation shield

System specifications

Energy	7.8 MeV
^{18}F-fluoride capacity	28 GBq / 750 mCi @ 2 h production
^{11}C-carbon dioxide	18.5 Gbq / 500 mCi @ 50 min production Specific activity: 300 GBq / 8 Ci / µmol
Total weight	49.6 metric tons
Self-shield dimensions	4.04 m × 2.27 m × 2.00 m (closed: L × W × H)

Site requirements

Minimum room size	5.8 m × 6.2 m (36 m^2), 2.5 m clearance height
Power requirements (operation)	30 kW
Power requirements (stand-by)	2 kW

GENtrace products

S9110AA GENtrace ^{18}F system

GENtrace cyclotron with self-shield and one ^{18}F- Nb 16 target system

P5110AC GENtrace ^{18}F Nb16 target system

Complete target system for ^{18}F-fluoride production, 1.6 ml fill volume

P5110AD GENtrace ^{18}F Nb16 target body

Spare target body for GENtrace ^{18}F Nb16 target system

P5110AF GENtrace ^{11}C target system

Complete gas target system for ^{11}C carbon dioxide production

P5110AG GENtrace ^{11}C target body

Spare target body for GENtrace ^{11}C gas target system

P5110AH GENtrace waste gas system

Waste gas system for ^{11}C

P5110AJ GENtrace ^{11}C specific activity demonstration

On-site demonstration of ^{11}C specific activity

P5450ZW GENtrace application training

Two days on site training for up to four participants.

P5450ZY GENtrace service training

Five days service training on site or at the GE TRACERcenter Academy

Imagination at work

‡The GENtrace cyclotron is not CE marked and cannot be placed on the market or put into service in the relevant countries until it has been made to comply with the all relevant Directive requirements for CE marking or otherwise obtained all required regulatory authorizations.

†based on a 2 hours per day / 5 days a week production schedule

#subject to local guidelines and verification required for the specific site

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